

# Relief of Chronic Lymphedema by Omental Transposition

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THERE HAS been no satisfactory treatment for severe chronic lymphedema of an extremity. The multiple operations that have been attempted indicate the continuing search for an ideal procedure. Correction of chronic lymphedema requires removal of diseased subcutaneous tissue and a method for continued drainage of stagnant lymph. The purpose of this paper is to describe a new one-stage operation for this problem. It includes removal of diseased subcutaneous tissue as well as mobilization of the omentum so that the lymphatic channels of the omentum might bridge discontinuity in the lymphatic system of the involved extremity.

## Pathogenesis

Pathophysiologically lymphedema appears to result from lymphatic flow obstruction associated with varying degrees of venous blockage.<sup>2</sup> Lymph which drains from a severed lymphatic channel is an excellent medium for fibroblastic activity. If infection is superimposed upon this fluid, progressive fibrosis can become even more exaggerated.<sup>4</sup> As fibrosis continues, it obstructs the lymphatic channels causing stagnation of lymph. Subsequently the lymphatic channels become dilated with eventual lymphatic valve incompetence.<sup>5</sup> The lymphatic vessels, which are overburdened and overdistended, are now unable to accomplish their function of absorbing excess fluid from the tissue spaces. This decrease in absorption in the presence of interstitial

spaces already saturated with high osmotic pressure lymph fluid can only lead to more edema and fibrosis in a continuing vicious cycle.

Based on the above concept of the pathogenesis of lymphedema, successful treatment would require the introduction of new lymphatic and venous channels into an involved extremity in order to bypass the area of lymphatic and venous obstruction. We wondered if it would be possible to mobilize the omentum with its rich lymphatic and vascular supply into an extremity for the control of lymphedema.

## Experimental Studies

*Surgery.* Ten mongrel dogs had their omentum fashioned into a long pedicle graft with preservation of the gastroepiploic vascular arcade. For mobilization into the lower extremity, the omentum was brought out of the peritoneal cavity and passed through a subcutaneous tunnel anterior to the inguinal ligament and parallel to the femoral vessels. A longitudinal incision was made on the anteromedial aspect of the thigh, and the skin was widely undermined. The omentum was then pulled from its subcutaneous tunnel into the leg wound and laid upon the underlying muscles. The skin over the omentum was then reapproximated. When mobilizing the omentum into the upper extremity, the structure was delivered from the upper pole of the abdominal incision and brought through a subcutaneous tunnel which had been made along the chest wall. A long incision was made on the anteromedial aspect of the foreleg, and the omentum was pulled from

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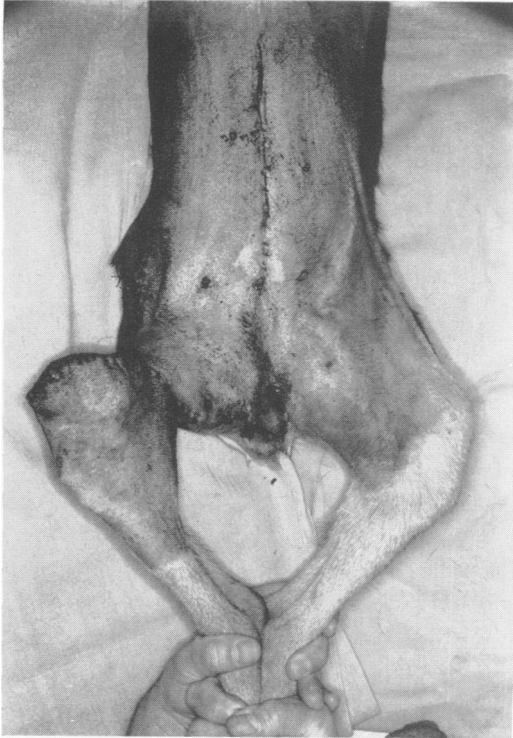


FIG. 1. Right leg of dog has been divided except for femur, femoral vessels and sciatic nerve. Experimental group of animals had the same procedure plus omentum which was brought down to the knee.

its subcutaneous tunnel and laid in the extremity as previously described for the hindleg.

One month postoperatively, 1-2 cc. of Pontamine sky blue dye was injected into the extremity, approximately 2 inches distal to the end of the implanted omentum. Forty-eight hours later, the area was explored, and dye was visualized in the omentum. When the distal omentum was explored, it was completely incorporated into the surrounding tissues of the extremity with no surgical planes of dissection present. Also noted was the extreme vascularity in the area of the omental apron and its junction with the underlying musculature.

No mortality and no unusual postoperative discomfort was noted among animals who had their omentum transposed. Post-

operative complications consisted of a small bowel herniation which developed 2 weeks after surgery, which was repaired uneventfully. In addition, there were two local wound infections which healed without difficulty.

*Lymphangiography.* Although the initial operative experience on dogs was encouraging, the question arose as to whether lymphatic connections did develop from the omentum to the extremity. An experimental preparation was made in which the hind limb of the animal was completely transected except for the femoral vessels, femur and sciatic nerve. The periosteum of the femur as well as the adventitia of the femoral vessels were stripped of tissue to remove any possible lymphatic pathways. A circumferential incision was made around the upper third of the thigh, and the muscles distal to the incision were removed as a muscle group resection to just above the

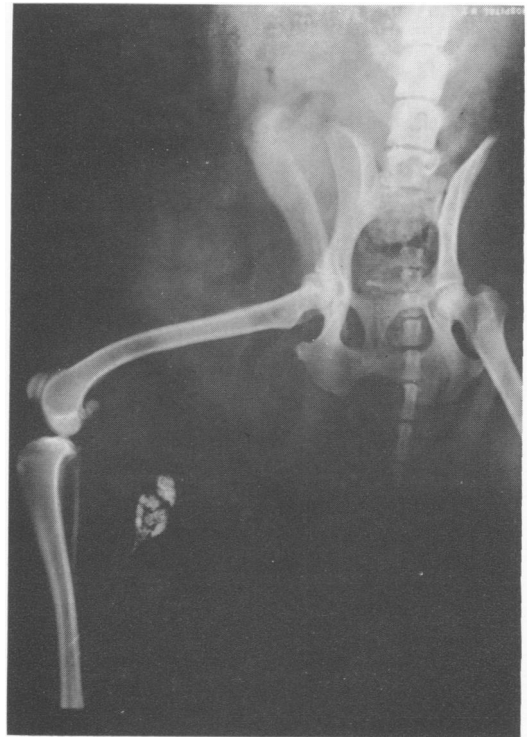


FIG. 2. Lymphangiogram of control animal showing ethiodol flowing only to popliteal lymph node after injection into paw.

knee. The widely undermined skin was closed over the defect as demonstrated in Figure 1. In the experimental group of animals, the defect in the leg was bridged by skin plus underlying omentum. Nine to 14 days later, 10 cc. of ethiodol were injected into the paw of the animal at the rate of 0.5 cc./min. In the control animals, ethiodol flowed only to the posterior popliteal node, but did not bridge the defect in the leg (Fig. 2). If the skin edges overlying the ends of the wound broke down and there was some muscle approximation between the thigh and the leg, an occasional lymphatic pathway was visualized in the retroperitoneal space. However, in the experimental group, ethiodol which had been injected into the paw was visualized in the lymphatics of the omentum in the peritoneal cavity and also in the intraperitoneal lymph nodes (Fig. 3, 4). There was no pathway for ethiodol to travel from the paw into the intraperitoneal lymph nodes other than by way of the omentum.

### Clinical Application

While animal experiments were being carried out, familiarity with omental manipulation was pursued at operation and autopsy to learn the technical feasibility of this procedure in humans. It became possible to mobilize the omentum so that it could reach the knee or the elbow, and on many occasions, even distal to these joints. These experiences coupled with the apparent success of the animal experiments justified the undertaking of this operation in man.

**Technic: Leg.** Under general anesthesia, a midline incision is made from approximately 2 inches above the umbilicus to the suprapubic area. The omentum is then freed completely from the transverse colon. The omentum is then removed from the major portion of the greater curvature of the stomach leaving the gastroepiploic arcade intact (Fig. 5). When the omentum is to be placed in the right leg, it is freed

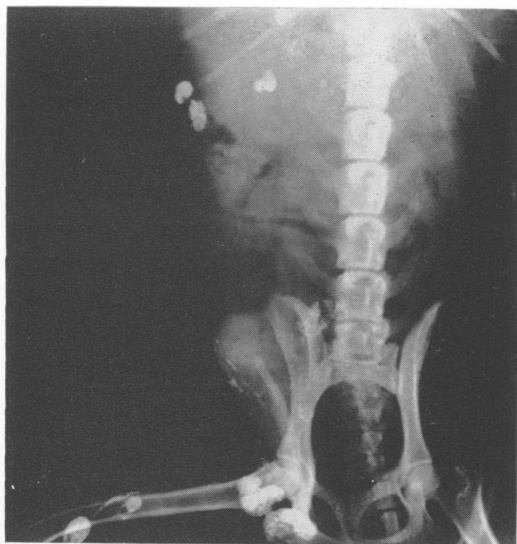


FIG. 3 AND FIG. 4. Anteroposterior and lateral view of lymphangiogram of animal with omentum bridging leg defect. Ethiodol injected into paw can be seen in lymphatics and lymph nodes within the peritoneal cavity.

from the left side of the stomach. If it is to be placed into the left leg, the right side of the greater curvature is freed. These



FIG. 5. The omentum is being removed from the greater curvature of the stomach. The dissection occurs on the stomach wall so that the gastropiploic arcade remains in the omental pedicle.

maneuvers allow the omentum to lie in a more direct route into the leg, thus permitting a slight increase in the length of the transposed omentum. Separation of the omentum from the stomach is carried out directly on the stomach wall so that the gastropiploic arcade is left intact in the omental graft. Either the right or left gastropiploic artery is divided depending upon the manner in which the omentum is to be swung. As the lengthening process is carried out, the omentum is brought down along the course of the leg to determine its length. It has always been possible to bring the omentum at least to the knee.

After the omentum is lengthened, it is carefully replaced into the peritoneal cavity. One must constantly be aware of the danger of kinking the omentum with subsequent venous obstruction and of the pos-

sibility of thrombi forming in the smaller veins of the structure.

The next step in the procedure begins by making a longitudinal incision on the anterior aspect of the thigh, 1 inch below the inguinal ligament. The incision is carried down the thigh medially to approximately 2 inches above the patella. The underlying thickened fibroedematous subcutaneous tissue is dissected from the skin following the plane of the superficial fascia. It is unwise to make these skin flaps too thin, because of the danger of subsequent skin necrosis. The limits of the dissection are the fascia lata laterally, the abductor longus medially, the inguinal ligament proximally and the patella ligament distally. All fibrotic material is removed from around the femoral artery and the femoral vein. When there have been marked fibrotic changes and frequent lymphatic infections in a leg, the femoral vein is often thrombosed and consists of nothing more than a thickened fibrotic cord.

After the upper leg has been prepared by removing fibroedematous tissue from the underlying muscle, the omentum is brought through a small opening in the peritoneum overlying the iliac vessels. By sharp and blunt dissection, a tunnel is created anterior to the femoral vessels, large enough so that the omentum may be carried through the tunnel without constriction. The tunnel should be approximately two finger-breadths wide. The omentum is brought through this tunnel with no torsion, after which it is opened as an omental apron and spread over the thigh muscles. It is usually necessary to divide partially the inguinal ligament to prevent any constriction on the omentum. When it is possible to bring the omentum into the lower leg, another subcutaneous tunnel is made along the medial aspect of the knee, and the omentum is carried through this new tunnel and laid along the anterior aspect of the lower leg (Fig. 6). Interrupted sutures are placed at vari-

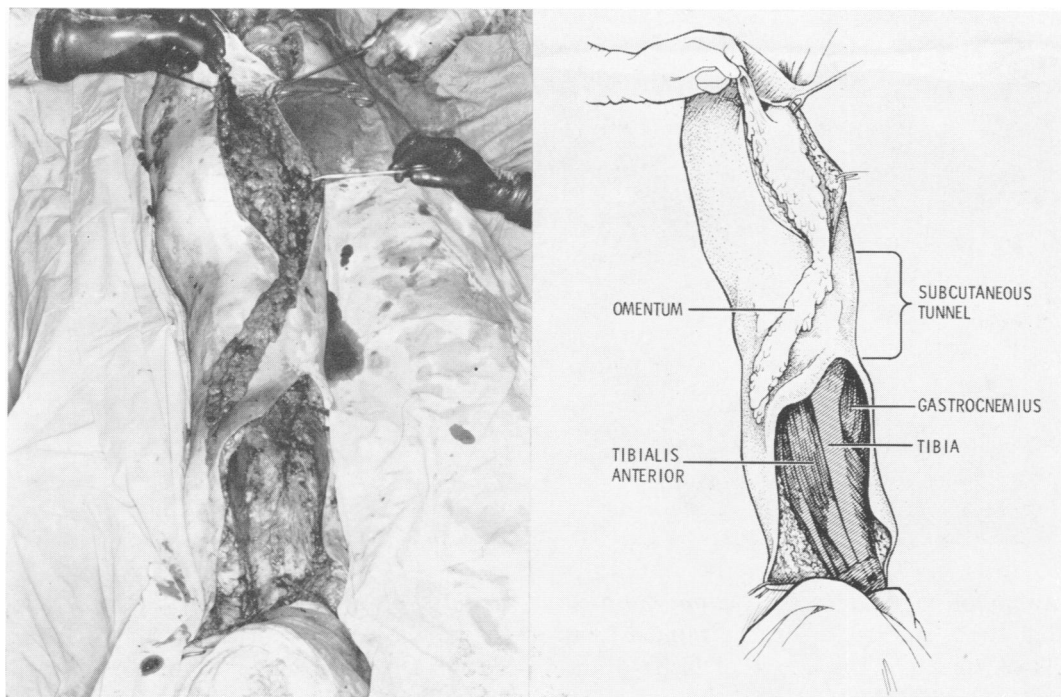


FIG. 6. Photograph and corresponding drawing showing the omentum prior to insertion into the subcutaneous tunnel at the knee.

ous positions along the edges of the omentum in the leg to hold it in place and to minimize any sheering effect.

Intraperitoneally the omentum is laid along the lateral pelvic gutter where several sutures are placed to prevent twisting of small bowel around the omentum. In addition, several sutures are placed between the peritoneum and the omentum at the exit into the femoral canal to prevent herniation of small bowel. This peritoneal closure must be snug but not tight enough to compromise the omental vessels.

The skin and subcutaneous layer of the leg wound are approximated individually. The abdominal wound is closed in a routine fashion. Several Penrose drains are placed in the abdomen and Hemovac drains are inserted along the omentum in the leg. These suction drains are usually left in place for 7 to 8 days until lymphatic regeneration is believed to have taken place between the lymphatics of the omen-

tum and those of the leg. If drainage from the suction catheters is minimal, the Hemovac can be removed as early as the fifth

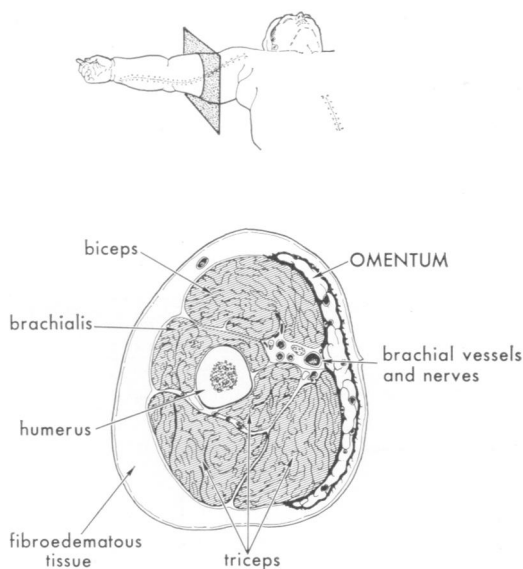


FIG. 7. Cross-sectional drawing of omentum in upper extremity.



FIG. 8. Note thickened fibroedematous tissue of upper arm. After a portion of this material has been removed, the axillary artery and vein are freed from surrounding scar tissue.

postoperative day. Daily lymph drainage from these suction tubes has ranged from 460 cc. to minimal amounts. During drainage, the patient is kept at bedrest, but active and passive motion of the legs is encouraged.

*Technic: Arm.* Through an upper midline incision the omentum is removed from the colon and stomach wall as previously described leaving the gastroepiploic arcade in the omental pedicle. The omentum is removed from the left or right portion of the greater curvature of the stomach, depending upon which gastroepiploic artery has the greater pulsation. If the right gas-

troepiploic pulsation appears stronger, then the omentum is removed from the left portion of the greater curvature of the stomach. The left gastroepiploic artery is divided thereby relying on the right gastroepiploic artery for vascularization in the omental pedicle. However, if any previous surgery has been performed in the gallbladder area or if there has been any inflammatory response along the right side of the greater curvature of the stomach such as peptic ulcer, the left gastroepiploic artery might be used as a vascular source to the omental pedicle. This would require freeing the omentum from the lower por-

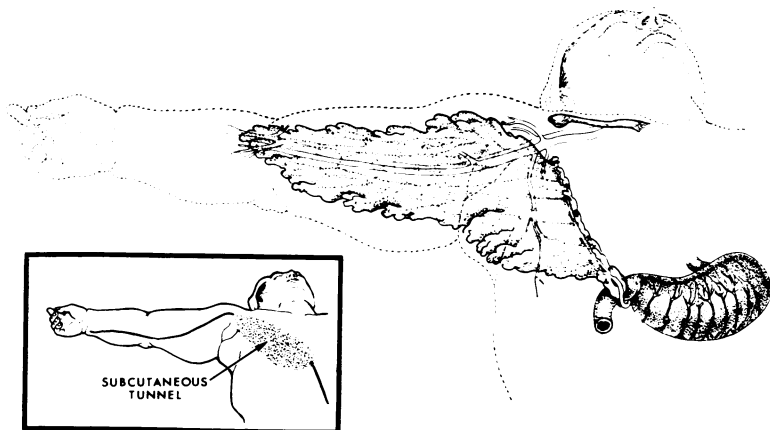


FIG. 9. Drawing of omentum crossing the axilla. Subcutaneous tunnel can be made with finger or scissor dissection.

TABLE 1. *Summary of Clinical Data*

| Initial | Status | Extremity | Condition   | Omental Transposition | Follow up (months) |
|---------|--------|-----------|---|-----------------------|--------------------|
| A. R.   | 56F    | R. arm    | R. rad. mastec.<br>4/10/61                                | 9/8/66                | 8                  |
| G. P.   | 47M    | R. leg    | Part. penectomy<br>11/17/60<br>Groin dissection<br>1/4/61 | 3/30/66               | 14                 |
| D. G.   | 24M    | R. leg    | Primary lymph.  | 9/22/66               | 8                  |
| M. L.   | 44F    | R. leg    | Groin dissection<br>9/29/64                               | 5/13/66               | 12                 |
| D. C.   | 14M    | R. leg    | Primary lymph.  | 10/25/66              | 7                  |
| E. G.   | 67F    | R. arm    | R. rad. mastec.<br>4/3/56                                 | 10/27/66              | 7                  |
| F. L.   | 61F    | L. arm    | L. rad. mastec.<br>2/17/55                                | 11/8/66               | 6                  |

tion of the greater curvature of the stomach with division of the right gastroepiploic artery.

After the omentum has been sufficiently lengthened, an incision is made on the anteromedial aspect of the edematous arm, just distal to the insertion of the deltoid muscle. When there is marked edema of the forearm and dorsum of the hand, the incision is continued along the medial aspect of the lower arm and onto the dorsum of the hand curving behind the metacarpal joints in a radial direction. This allows for removal of fibroedematous tissue from both the lower arm and the hand. When there are edematous changes on the dorsum of the fingers, incisions on these digits are not justified since postoperatively, much of the edema spontaneously regresses.

The subcutaneous fibroedematous tissue of the arm is excised for no more than one-third of its circumference (Fig. 7). It is important to make skin flaps thick enough to avoid necrosis. Fibrotic tissue surrounding the axillary vein and artery is removed (Fig. 8). Then a subcutaneous tunnel is made from the upper pole of the abdominal incision to the upper pole of the arm incision between the skin and the chest

wall; an area which is usually avascular. If bleeding occurs, however, a small pack placed in the subcutaneous tunnel is sufficient for control. After the tunnel has been made, the omentum is pulled through without tension and then laid as an omental apron on the overlying muscles (Fig. 9). The omentum will usually reach the elbow (Fig. 10). It is important that no tension be put on the omentum, since this might jeopardize the venous outflow from the omentum and lead to a serious complication.

After the omentum has been placed in the extremity, it is secured by several sutures to the underlying musculature. Fine chromic catgut sutures should be used especially if there has been a history of lymphangitis. The abdominal wound is

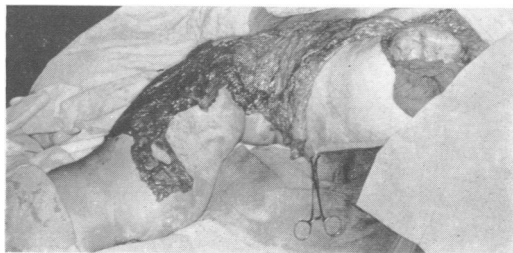


FIG. 10. Omentum extending across the axilla to the elbow.



FIG. 11. Left: Preoperative photograph showing limit to which patient could elevate right arm. Right: Postoperative photograph showing functional improvement. Circumferential measurements of right arm have decreased 1-2 $\frac{3}{4}$  inches at fixed points.



closed with the omentum brought out at the upper pole of the abdominal incision. The abdominal closure must be loose enough to prevent constriction of omental blood vessels, yet not so loose that a loop of small bowel might herniate through. The skin and subcutaneous layers are closed in a routine fashion. Hemovac and Penrose drains are routinely used.

### Results

Seven patients, all with severe incapacitating lymphedema, have undergone omental transposition. Two were operated upon because of congenital changes in the lymphatics of the lower extremity, two had lymphedema secondary to radical groin dissection, and three suffered from post-mastectomy edema (Table 1).

*Cosmetic.* The patients who have undergone omental transposition have demonstrated varying decreases in the circumferences of involved extremities. Decreases

in size is to be expected since a certain percentage of fibroedematous tissue is removed at the time of surgery. Although a decrease in size of a limb is advantageous, cosmetic appearance is not indication enough for omental transposition. Only when a limb becomes so enlarged as to make a patient socially useless or unacceptable is surgery indicated.

*Lymphangitis.* Six of the seven patients operated upon had been troubled preoperatively with severe cellulitis and lymphangitis. One had 11 exaggerated episodes of lymphangitis and cellulitis, all of which required hospitalization. During the 6 months prior to omental transposition, he was hospitalized six times. He states that during this period he had daily shaking chills and fever. Another patient claimed to have had shaking chills and fever approximately every 2 weeks for several years.

One patient who preoperatively had in-

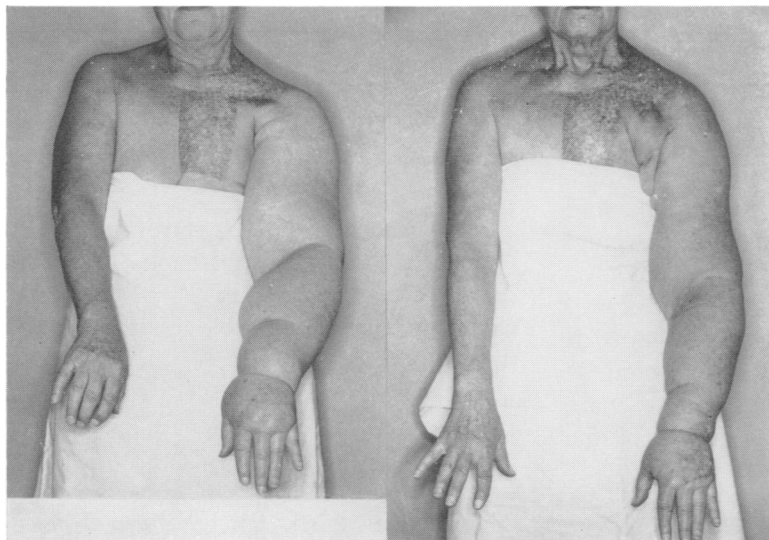


FIG. 12. Left: Preoperative photograph showing marked radiation changes. Right: Postoperative photograph showing improvement of from 1-3¼ inches in circumferential measurements of the left arm at fixed points. The decrease in arm size has not completely eliminated pain in shoulder secondary to radiation destruction of bone.

fection in his leg has not been relieved since he must occasionally take antibiotics to control erythematous changes in his leg. However, the remaining five patients have all shown marked decrease in frequency and severity of this inflammatory process. The patient who had experienced daily chills and fever for six months has had only two short episodes of infection in the first postoperative year.

**Function.** There has been increased ability of all the postoperative patients to use their edematous extremities. Severe brawny edema which was resistant to firm palpation was always present before surgery. Postoperatively, the consistency of the skin and subcutaneous tissue changed, and has never regained its preoperative firmness. Four patients with lymphedema of their legs preoperatively were unable to flex their knees more than 10 to 15 degrees. They are now able to do deep knee bends. Patients with postmastectomy lymphedema have also improved in ability to move their arms. Simple activities were difficult and time-consuming preoperatively, but postoperatively can be done automatically and easily (Fig. 11).

**Pain.** Preoperative pain was eliminated by omental transposition in five of the six

patients. The patient not relieved of pain was 12 years post radical mastectomy and had lymphedema of the arm, severe irradiation changes of the chest wall and shoulder as well as radiation necrosis of clavicle, scapula and ribs. It was hoped that by diminishing the size of the involved arm, there would be less distraction of the fractured clavicle. There has been a decrease in the size and weight of her arm as well as a subjective lessening of pain in the shoulder (Fig. 12). However, pain has not been completely alleviated.

### Complications

Two patients developed complications secondary to operation; one a wound infection in the groin which cleared spontaneously with local treatment. It was feared that infection would involve the omentum and decrease its efficiency as a lymphatic wick. However, this was not so as the patient has done well with almost complete disappearance of severe attacks of lymphangitis. However, he developed a small inguinal hernia at the site of infection.

The other complication was a severe wound separation in a postmastectomy

edematous arm. Because of the creation of thin skin flaps which were undermined for approximately 50% of the circumference of both the upper and lower arm, a 1-inch strip of non-viable skin developed in the suture line. In order to debride the area, sutures were taken out prematurely, and the wound separated widely. The wound was treated with sprays of saline and hydrogen peroxide and healing occurred ultimately. This complication can be avoided by making skin flaps thick enough and by not undermining the skin flaps for more than a third of the circumference of the involved extremity.

### Conclusions

Chronic lymphedema can be a major problem. Not only may there be severe functional impairment, but there are frequently cellulitis and lymphangitis, psychological disadvantages of any severe cosmetic disability, and danger of developing lymphangiosarcoma in the edematous extremity.

Omental transposition has been performed on seven patients. All showed objective as well as subjective improvement in terms of cosmetic appearance, and an increase in functional activity of the involved extremity. There was only one patient in whom episodes of cellulitis and lymphangitis were not eliminated or diminished postoperatively.

The patients were advised to wear supportive bandages on their extremities up to the lower edge of the transposed omentum. However, this instruction has not been carried out faithfully by most. Of the four patients who had surgery performed on their leg, two have totally eliminated elastic supports since they claim they have no discomfort, and they feel that elastic stockings produce discomfort. Two patients who had marked preoperative edema at the ankle have been advised to wear a low anklet compression support to give

maximum compression to this area. The majority of the patients operated upon were overweight preoperatively and continue to be so.

### Summary

Many procedures have been developed to rectify chronic lymphedema. There has been no one-stage procedure which causes slight disfigurement to the patient, removes diseased fibroedematous tissue, and mobilizes large numbers of the patient's own lymphatic channels in order to bridge areas of lymphatic discontinuity. To achieve these goals in patients with chronic lymphedema a new operation has been devised. This operation involves mobilization of the omentum so that it may bring its lymphatic and vascular-rich supply into a limb with the hope of having lymphatic and venous connections develop and function between the omentum and the extremity. Experimental work using lymphangiographic techniques in dogs demonstrated that lymphatic continuity can be developed between the omentum and an extremity. The operation is technically feasible and does not present undue hazards to the patient. Results in seven patients have been very encouraging.

### Addendum

M. L., 14 months post omental transposition, recently underwent an exploratory laparotomy at which time the omentum appeared normal. The patency of the omental lymphatics was investigated by injecting 5 cc. of Direct Sky Blue dye and 30 units of Hyaluronidase into the mid anterior thigh. The foot was dorsi and plantar flexed for 1-2 minutes. Several minutes later, blue dye was clearly observed in the lymphatics of the intraperitoneal omentum.

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#### DISCUSSION

DR. FREDERICK L. REICHERT (San Francisco): Mr. President, we have had some interesting papers, but no one discussed or mentioned lymphatics. The previous paper has obviously involved lymphatics—not mentioned. So it's time we started arteries, veins, lymphatics—and looked for them.

Now, this paper is interesting because he has tried to get rid of edema. I wonder if he got rid of the edema by elevation before he did this operation upon the omentum and these tissues. Certainly after two weeks you will have a remarkable change in the appearance of these limbs, just as he did by operation.

Lymphedema causes a fibrosis beneath and in the subcutaneous tissue. Now, in his specimen that was shown in color I didn't see any of that fibrosed subcutaneous tissue. I don't know where it was, but we always have it in pure lymphedema, whereas cardiac edema involves the whole tissue of the leg or the arm, and this lymphatic edema is limited not to the muscles, but the subcutaneous tissue.

Years ago, I think it was Sistrunk who devised an operation for taking out this tissue, and we did that, and I think our results were just about as good as he has demonstrated here.

The lymph nodes are taken out when you do a radical, but if you get infection, like in carcinoma of the breast and the axilla, then you cause scar tissue, and you get this involvement of the arm. It will go down if you treat it right away, and there is no fibrosis in the subcutaneous tissue; but if you allow it to go on, it causes a thickening edema of the subcutaneous tissue and skin.

I'm not sure that the approach of trying to shunt this lymph stasis by putting in the omentum is the entire answer. I think lymph nodes may regenerate. Once we took out tuberculous lymph nodes in the neck bilaterally; two years later they came back. Where did they come from? Either he didn't get all of the lymph nodes, or there were tiny ones left; and I wonder whether lymph nodes regenerate.

Also, they must have sympathetic fibers in them. If you get stung by a Portuguese man-of-war, your lymph glands become huge, but if you give an antihistaminic, they go down in twenty minutes, and with it the pain.

So there are a lot of questions about the lymphatics; they haven't been completely studied, and it's an open field for these young men. There is

an open field for the sympathetics in this relation, too. This paper is on the right track, but I'm not so sure that it's the answer.

DR. BROOKE ROBERTS (Philadelphia): Dr. Creech, Gentlemen: This has been a problem in which we have been interested for several years; namely, trying to reestablish lymphatic flow—and the authors kindly let me see their manuscript prior to the meeting.

When we first started, we tried to induce new lymphaticovenous channels by anastomosing lymph nodes into the venous system. Although we were able to show that actual anatomical connections were maintained, we were never able to demonstrate functional lymphatic drainage into the venous system through these anastomoses, so we, too, tried the procedure which has been described this morning—however, only on an experimental basis. We, too, took the omentum and put it into the legs of dogs after the lymphatics had been obstructed. We also took defunctionalized loops of bowel and put those down into the thigh. The bowel, as you know, is richer in its lymphatic system than in the omentum, and we had hoped that there would be connections established between the lymphatics of the leg, and that of the bowel or omentum.

Lymphangiographically we were never able to demonstrate such connections. Today, in the slide we were shown, it looks as if there may have been connections established.

Certainly the need for an operation in which lymphatic drainage is reestablished is obvious to all of us, and I hope that the operation described may prove to be such; however, I would very much like to see direct lymphangiographic connections established beyond all question before completely accepting this operation as accomplishing what it sets out to do.

Certainly with the dissection of the subcutaneous tissue which was described, a portion of the old Kondolean operation has been accomplished, and this may in part be responsible for some of the benefit that we have seen.

DR. W. DEAN WARREN (Miami): Dr. Creech, Ladies and Gentlemen: I would certainly like to thank Dr. Goldsmith for what I think is a very important contribution, and a beautiful presentation.

I rise to give support to this operation, through the personal experience of one patient who was referred to me about a year and a half ago with lymphedema praecox. It had developed in a young